



RAYTECH USA, Inc.

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Perkasie, PA 18944 USA

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THREE PHASE VOLTAGE OPTION

Model: T-REX

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SAFETY PRECAUTIONS!

1 – 0

The following safety precautions must be observed during all phases of operation, service, and repair of this instrument. By purchasing this equipment the purchaser assumes all liability for the operation and use of this equipment. The intended use of the instrument, its design and manufacture, is to be conducted within the precautions or other specific warnings located within this manual. Failure to comply with these precautions and other specific warnings violates safety standards of design, manufacture, and intended use. Raytech USA, Inc. assumes no liability for the operation and use of this equipment.

SAFE OPERATION

Only qualified knowledgeable persons should be permitted or attempt to operate this test equipment. All test personnel should fully familiarize themselves with the correct application and operation of this and all test equipment prior to operation. Persons directly and indirectly engaged in the operation of this test equipment should keep clear of all high voltage apparatus while conducting tests and measurements.

BEFORE APPLYING POWER

Do not vary the input power source voltage level (IE..Connected to a variable AC power source). The T-Rex and TR-Spy, TR-Mark II and TR-Mark III 250 auto-sense the input power from the mains plus from 100 to 240 vac 50/60Hz. Varying the input voltage will cause the test voltage to vary and result in a higher or lower test voltage than indicated.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to a properly grounded receptacle. The power cord supplied with the equipment must be connected an electrical receptacle with an electrical ground (safety earth ground). Non grounded instruments are dangerous and may cause instrument damage

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power, discharge circuits, and remove external voltage sources before touching components.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Raytech USA service department for service to ensure proper operation and that safety features are maintained.

Instruments, which appear damaged or defective, should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

UNCRATING:

2 – 0

Unpack the new T-Rex and check to see that you have the following items:



T- Rex

*Interface
Cable

H & X Lead
Connection

Power
Cable

Manual

Cable Bag

If any of the above items are missing or damaged contact your local representative or Raytech USA, Inc. immediately.

RAYTECH Toll free service & support telephone: 1 888 4 THE SPY (484 3779)

* Note 1:

The T-Rex Fieldcase is a waterproof design that incorporates a pressure relief valve that should be slightly open when encountering atmospheric changes; i.e... Airplane Travel, High altitudes, etc... Close the valve when transporting the equipment in wet conditions.

* Note 2:

When the optional hard travel case (part number **ST0 822**) or the optional soft travel case (part number **MC845**) is ordered with a new T-Rex, the cable bag depicted above is omitted from the shipping box.

* Interface cable: There are 2 different interface control cables:

For TR-Spy / TR-Mark II systems use part no:

For TR-Mark III / TR-Mark III 250 systems use part no:

The Raytech three phase voltage system option **SM206 (T-Rex)** is an optional system accessory for 3-Phase transformer ratiometer test sets designed by Raytech (ie...TR-Spy, Mark II).

T-Rex was designed to allow Engineers and Test Technicians the ability to test the phase relationships and actual voltage ratios of transformer windings while applying three phase voltage. The system can precisely measure the ratio and angular relationship of transformer phases with voltage applied to all three phases simultaneously. This is a "real condition" measurement, which allows greater understanding of how the transformer will operate connected to a 3 phase system.

The T-Rex is especially useful for transformers with:

- Phase relationships other than 30°.
- Zig Zag windings.
- Uncentered neutral points.
- Suspected broken, damaged, or missing core laminations.

The T-Rex is contained within a separate yellow case and comes complete to connect to the Raytech TR-Spy or Mark II, three phase transformer ratiometer.

The system: The T-Rex is a completely new approach in technology. Raytech, an innovative research and development company, has developed a system for three phase measurements in a single lightweight package. There are no other systems available to the engineer that allows such quick and accurate measurements. The system is precision built and extremely accurate.

Ease of use: The T-Rex is an intelligent system option that communicates with the TR-Spy, TR-Mark II, TR-Mark III and TR-Mark III 250 during three phase voltage measurements. No additional programming is required. The system and option can operate a full 3 phase testing sequence with a single push button operation. Connect the leads, Select the transformer configuration and vector phasing, Press GO to initiate the test.

Unique Measuring Technique: This newly designed option incorporates high precision circuitry for phase resolution measurements. The design utilizes a precision crystal controlled frequency generator for precise phase measurements.

Operation: The T-Rex applies a preset, three phase voltage on the HIGH windings of the transformer and measures back through the LOW side of the transformer. The results are reported on the easy to read display of the Raytech Ratiometers.

Compact Design: The T-Rex is a lightweight option that comes complete with its own rugged waterproof Fieldcase.

Simple Maintenance: There is No maintenance required. There is No calibration procedure (No potentiometers to turn). This is due to the utilization of high precision components in the design.

Advanced Protection: Upon powering on the system initializes itself with a self-calibrating, circuit checking sequence. If any problems are detected during this initialization period, or during operation, the operator is immediately notified. The system constantly monitors the condition of the transformer under test.

THEORY OF OPERATION

4 – 0

Circuitry Design

4 – 1

The T-Rex system is designed to produce and generate three (3) perfect sine waves from DC coupled ± 24 Volts. The incorporation of D/A converters with the proper amplification produces an AC sine wave on three (3) output channels. These sine waves are produced with identical amplitudes and are shifted in phase 120° . The T-Rex is basically a smart artificial 3 phase generator. This system is designed to handle loads with an impedance as low as 0.5 ohms.

All system measurements are conducted in the appropriate ratiometer connected to the T-Rex. No measurements are conducted by the T-Rex. Standard ratiometer measurements can be made directly through the T-Rex without any influence.

Design Consideration and Phase Rotation

4 – 2

The T-Rex system was designed to be used world wide with consideration to test engineers utilizing various specifications. Nomenclature and operation of the T-Rex was decided upon with that consideration.

The T-Rex system was designed to assist the engineer in making precise phase angle measurements. The T-Rex measurements will indicate phase angles of $\pm 180^\circ$.

The ratiometer, working in conjunction with the T-Rex, senses the phase rotation by $\pm 180^\circ$. The measured result indicates to the engineer that the phase relationship is in a clockwise or counterclockwise direction. With this indication the engineer is able to adjust the vector grouping (Phase displacement) number on the ratiometer to correspond to the closest relationship in 30 degree increments. This is done to allow for greater accuracy of the phase relationship measurement.

For example:

Measurement of a transformer with a phase shift of 42° .

Select and measure the transformer with a phase displacement (Vector Group) number 00.

The system would measure and display a phase displacement of 42° .

The engineer would then adjust the phase displacement (Vector Group) number selection from a 00 to 10 (10 indicates a 30° shift). The resultant reading from the Ratiometer and T-Rex would then be 12.0° and be a more accurate phase result.

Rotation convention and nomenclature:

The convention of positive (+) Rotation and negative (-) Rotation is predetermined by the software and the customers nomenclature.

All TR-Spy and Mark II systems dispatched prior to May 2002 are sent with the following convention: A Transformer with the following configuration D-Y 1 would have a (+) Positive 30° result. And a transformer with a configuration of D-Y 11 would have a (-) Negative 30° result.

The reverse convention (D-Y 1 (-) negative 30° & D-Y 11 (+) 30° positive) can be achieved by requesting a software change for the TR-Spy or TR-Spy Mark II from RaytechUSA.

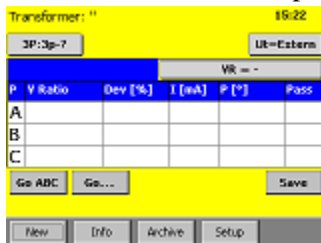
All TR-Spy Mark II systems with firmware revision 2.23 and higher have the following selection included in the software menu: Press **Setup** Select **TRex Phase angle** Select **is Positive** or **is Negative**.

Rotation convention and nomenclature: cont.

TR-Mark III 250 and TR-Mark III 250 systems:

Access to the polarity (sign) change on the TR-Mark III systems is located in the Service code menu.

1. From the Test Screen press **Setup**.



2. The Setup screen appears:



3. Press the **Service** Button and Enter **3000#**



4. The Following screen appears:



Select **Yes** or **No**.

SPECIFICATIONS

5 - 0

MODEL:	T-REX
SIZE:	L: 18.5ö (470 mm) W: 14.6ö (371 mm) H: 7.5ö (190 mm)
WEIGHT:	17.2 lbs. (7.8 kg)
INPUT POWER:	100 to 250 vac 50 / 60 Hz Autoranging
TEST VOLTAGE:	Three Phase, Internally Selected
PANEL DISPLAY:	Indication lamps
FRONT PANEL:	Sealed, Anodized aluminum
INTERFACE:	25 Pin connection to TR-Spy or Mark II / Centronics Parallel Printer

Measurement Parameters

PHASE ANGLE: ± 180 Degrees **ACCURACY:** ± 0.1 Degree **RESOLUTION:** 0.01 Degree

Temperature

Operating: - 10° C to 60° C Storage: - 40° C to 70° C

Cable Set

3 Phase cable extension set
Interconnect Power supply cord
Interconnect Signal/Printer Cable for TR-Spy, Mark II
Or
Interconnect Signal/Printer Cable for TR-Mark III
AC Power cord
Manual
Cable bag
T-Rex shoulder strap

Features

Automatic measurements of Voltage Ratio and Phase Angle relationship
Automatic selection of test voltage frequency
Outputs a pure three phase sine wave
Designed to measure phase relationships other than 30°
Remote controlled by TR-MARK III or TR-Spy MARK II
Single push button operation
Single hook up to the transformer
Heavy duty protection circuitry
5 Year standard warranty

* Specifications are subject to improvement at anytime.

WARNINGS!

BEFORE OPERATING THIS OR ANY OTHER TEST EQUIPMENT READ ALL SAFETY WARNINGS AND UNDERSTAND THEM FULLY.

DO NOT VARY INPUT VOLTAGE (MAINS) AFTER POWERING ON TEST SET.

The T-Rex and TR-Spy or Mark II auto-senses the input (mains) voltage from 100 TO 250 vac 50/60 Hz. The input voltage detector locks in the test voltage range.

If the input voltage (mains) is varied after the system is powered on the actual test voltage may be higher or lower than indicated and damage to the test set may result.

CONNECTION:

6 -

1

Connection of the T-Rex to Raytech 3-Phase Ratiometers is straight forward and easy.

TR-Spy, TR-Mark II: Connecting to T-Rex

6 - 2

Requires Interconnect cable: Part No: 1050A-05001 (25 pin Parallel)

1. Connect the two short Red leads from the H & X connectors located on the top, right side of the T-Rex (marked TO TURNS RATIO SPY) to the H & X connectors on the TR-Spy/Mark II.
2. Connect the 25 pin Interface cable from the connector located on the middle- right side of the T-Rex (marked TO TR SPY) to the Printer port of the TR-Spy/Mark II.
3. Connect the Power Interface cable from the connector located on the bottom- right side of the T-Rex (marked POWER OUTPUT) to the Power connector of the TR-Spy or Mark II.

TR-Mark III / TR-Mark III 250:

6 - 3

Requires Interconnect cable: Part No: 1050N-05002 (25 pin Parallel to 4 pin Lemo)

TR-Mark III / TR-Mark III-250 systems provide a separate plug to connect to the T-Rex module.

1. Connect the two short Red leads from the H & X connectors located on the top, right side of the T-Rex (marked TO TURNS RATIO SPY) to the H & X connectors on the TR-Mark III.
2. Connect the 25 pin Interface cable from the connector located on the middle- right side of the T-Rex (marked TO TR SPY) to the 4 pin Lemo connector on the front panel of the TR-Mark III.
3. Connect the Power Interface cable from the connector located on the bottom- right side of the T-Rex (marked POWER OUTPUT) to the Power connector of the TR-Mark III system.

T-Rex connection to Transformer under Test: All systems

6 - 4

4. Connect the multi-colored test lead cables that were supplied with the Ratiometer to the respective connectors, H & X, located on the top, left side of the T-Rex (marked TO TEST OBJECT). The clip lead end would then be connected to the respective connections on the transformer under test (Note: The long Red extension cables may be used, if required).
5. Connect the power cord supplied with the Ratiometer to the POWER INPUT of the T-Rex. Plug the power cord into a grounded 100 to 250 vac outlet.

OPERATION

7 - 0

After following the previous connection instructions, switch on the power to the Ratiometer and T-Rex. (Power on sequence is not critical as the Ratiometer and T-Rex communicate constantly). After a 2 second delay both systems should turn on.

The T-Rex should have all three phase lamps illuminated and the Ratiometer should have the display screen illuminated.

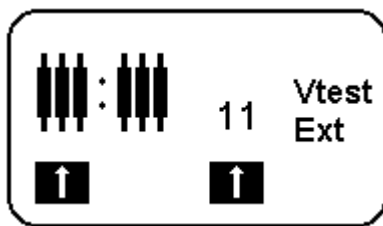
TR-Spy or Mark II:

7 - 1

The first step in operation of the T-Rex with the TR-Spy or Mark II Ratiometer is to ascertain the correct Vector phasing (Phase displacement) of the transformer under test if unknown (See also **Test Result Notes** on the next page). This can be accomplished by running a standard Ratio test on the transformer using the TR-Spy or Mark II.

If the Phase displacement is known proceed to step 2.

1. Select the correct transformer configuration on the TR-Spy or Mark II then select **0** if the Vector phasing is unknown. Run a standard ratio test (refer to the TR-Spy or Mark II manual). The TR-Spy, TR-Mark II or TR-Mark III 250 will display the correct vector phasing at the completion of the test.
2. Select the following screen on the TR-Spy or Mark II to initialize operation of the T-Rex:



T-Rex Operation screen

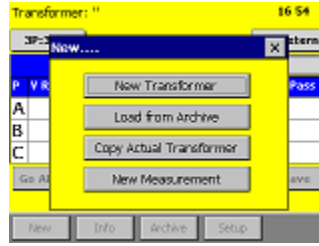
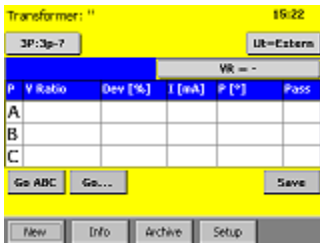
3. Enter the Phase displacement number or enter **0**.
Note 1: The Phase displacement (number 11 shown in the example) should be the same as previously tested. The Phase displacement number can be changed if desired.
Note 2: By selecting the Phase displacement prior to testing, the actual phase result will be the most accurate phase result obtainable. The displayed phase is then added or subtracted from the vector setting. For example: Phase displacement of 1 is set and the instrument shows 0.13° result. The actual phase displacement is 30.13°
4. Press **GO** then **ALL** on the TR-Spy or Mark II and the test sequence will check, calibrate, and test each phase sequentially (A, B, C) while applying three phase voltage to the transformer.
5. The Results of the voltage ratio and phase relationship will be displayed on the TR-Spy or Mark II screen.
6. End of Test. It is now possible to print or store the test results.
(see the TR-Spy or Mark II manual)

Testing Notes:

1. Transformers may have a nameplate that lists phase displacements referred to zero degrees. Select **0** as the phase displacement and test. Afterwards check the results against Nameplate.
2. Greater accuracy of the actual phase displacement can be achieved by selecting a vector grouping as close to the actual phase displacement as possible. For example: If the initial vector grouping selected was **0**(0°) and the resulting phase was 62° then select vector phasing **2** ($2 \times 30^\circ$).
3. The Phase displacement result is the phase relationship between H1 and X1, H2 and X2, etc

From the Test Screen select δ New

Then Select δ New Transformer.



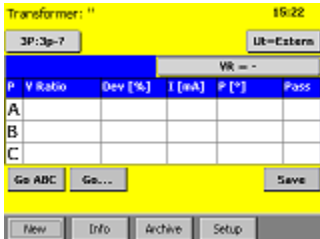
The system will ask if you want to save the δ Actual Transformer.
Select δ Yes to save or δ No to continue.

The Transformer Test Selection screen appears.



For use with the T-Rex select δ 3P

Selection is made. Next go to Test Screen press δ Go



Press Go ABC. The system will first detect the Vector Phasing 1..11 then will display the Voltage ratio of each phase tested.

End of Test. It is now possible to print or store the test results.

Error Messages from TR-Mark III / TR-Mark III 250:

- T-Rex not found: Trying to measure without a T-Rex (3P Configuration) not connected.
- 3P:3P only with Voltage Ext: Improperly connected T-Rex cables and leads.

Testing Notes:

1. Transformers may have a nameplate that lists phase displacements referred to zero degrees. Select δ 00 as the phase displacement and test. Afterwards check the results against the nameplate.
2. The Phase displacement result is the phase relationship between H1 and X1, H2 and X2, etc

WARRANTY

RAYTECH USA, Inc. warrants to the original purchaser of any new T-Rex, 3 Phase voltage option, that it will be free from defects in material and workmanship under normal use and service for a period of 2 years from the original date of shipment. An additional 3 year extended warranty is provided, at no cost to the end user, for the products covered under this warranty if the products are returned on each calendar year from the original date of shipment, prepaid, to Raytech USA, for system evaluation. Failure to do so will void the additional extended warranty.

The obligation of RAYTECH USA, Inc. under this warranty is limited, in its exclusive option, to repair, replace, or issue credit for parts or materials which prove to be defective, and is subject to purchaser's compliance with the RAYTECH USA, Inc. warranty claim procedure as set forth within this manual.

This warranty covers only those parts and/or material deemed to be defective resulting from manufacturer's workmanship. The liability of RAYTECH USA, Inc. shall be limited to the repair, replacement, or issuance of credit for parts deemed defective within the meaning of this warranty. Costs for labor or other expenses that may have occurred incidental to the inspection, repair, replacement, or issuance of credit for such parts and/or materials shall be the sole responsibility of purchaser. This warranty shall not apply to any accessories, parts, or materials not manufactured or supplied by RAYTECH USA, Inc.

Equipment must be returned prepaid with a Return Material Authorization (RMA) to:

RAYTECH USA, Inc.
118 S. 2nd Street
Perkasie, PA 18944
USA
Tel. 1 267 404 2676
Fax. 1 267 404 2685
www.RaytechUSA.com

or RAYTECH GmbH
Oberebenstrasse 11
CH-5620 Bremgarten
Switzerland
Tel. + 41 56 640 0670
Fax. + 41 56 640 0674
www.Raytech.ch

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper and unauthorized modifications or misuse and abuse of the product, negligence, alteration, modification, faulty installation by the customer, customer's agents or employees. Attempted or actual dismantling, disassembling, service or repair by any person, firm, or corporation not specifically authorized in writing by RAYTECH USA, Inc.

Defects caused by or due to handling by carrier, or incurred during shipment, trans-shipment, or other move.

Inadequate maintenance by the customer, second source supplied software or interfacing, operation outside the environmental limits, or improper site preparation.

Exclusive remedies provided herein are the customer's sole and exclusive remedies.

RAYTECH USA, Inc. shall not be liable for any damages resulting from the use of this equipment whether direct, indirect, special, incidental, or consequential damages, or whether based on contract, tort, or any other legal theory.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED.